A Summary of the Stakeholder Consultation Workshop On Extreme Sea Levels

Held on 31 May 2006, Sandy Bay, Tasmania

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5 September 2006

1 Introduction

A Stakeholder Consultation Workshop on extreme sea levels was held in Sandy Bay, Tasmania, on 31 May 2006. The workshop had two primary aims (see Appendix A for the Agenda):

1. to provide information on climate change, sea-level rise and sea-level extremes, with particular relevance to the Australian (and, in particular, the Tasmanian) coastline, and

2. to seek information from stakeholders on the way in which they would like the statistics of sea level extremes presented.

The first part of the workshop centred on a talk by John Hunter entitled 'Setting the Scene' (see Appendix B for a summary of the slides). The talk summarised modern sea-level rise within the contexts of the most recent glacial cycle and future climate projections. The workshop concentrated, however, on *the effect of an increase of extreme sea levels on fixed coastal infrastructure*, rather than changes to mobile shorelines (e.g. the erosion of sandy beaches). Two statistics of extreme events were defined:

- the *Return Period*, or RP, which is the average time between individual extreme events, and

- the *flood proportion*, which is the proportional time that a prescribed sea level is exceeded.

In addition, *multiple events* were loosely described as more than one event occurring within a 'short' time period (where the meaning of 'short' was left open for subsequent discussion). A graphic explanation of these statistics is provided on slide 14 of Appendix B ('Three Important Questions').

Three Questions were then posed:

I Is the *Return Period* important to the stakeholders?

II Is the *flood proportion* important to the stakeholders?

III Are *multiple events* important to the stakeholders?

The second part of the workshop consisted of discussions of these three Questions in four breakout groups (see the final slide of Appendix B), the results being summarised in the next section.

2 Summary of Discussions Within Breakout Groups

2.1 Areas of Interest

The participants had a wide range of interests, from both planning and maintenance perspectives, including:

- public services (e.g. roads, bridges, sewerage, storm water drains, water supply),
- public amenities (e.g. historic buildings and sites, beaches, sports grounds, camping grounds, caravan sites),
- Aboriginal artefacts and sites of Aboriginal heritage,
- urban and rural residential sites,
- industrial sites (e.g. aquaculture), and
- marine facilities (e.g. ports and slipways).

These interests were reasonably evenly distributed among the four breakout groups.

2.2 General Responses to the Questions

As regards the main three Questions (I - III of Section 1, 'Introduction'), two groups ranked I (the Return Period) as the most important and II (the flood proportion) as the second most important, while the other two groups thought the reverse. It therefore appears that the *Return Period* and the *flood proportion* are or roughly equal importance and should therefore both be provided in any assessment of extreme sea levels.

There was significant discussion about the meaning of Question III (concerning multiple events) with no clear consensus, other than it being the least important of the three considerations. It may be that the Question was too loosely defined or that the participants did not fully understand some of the implications of the Question. One important implication is that the value of the Return Period may be severely distorted if relatively rare events occur in clusters of closely-spaced extreme events. For example, if an event happens on 3 consecutive days and then does not re-occur for 10 years, is the Return Period 10 years or 10/3 years? An important consideration raised during the discussions was whether events were spaced closer together than the 'remediation response time' – if so, then the events could reasonably be counted as a single event. In cases where multiple events cause increased damage compared with a single event (e.g. to a road or to building foundations), the relevant statistic is probably the *flood proportion*, as addressed by Question II. For general use, it is probably best to base a Return Period on a 'standard' timeframe (probably one or two days) within which multiple events would be considered as one. Stakeholders with a different interpretation of the importance of multiple events would require specific statistics developed for their particular needs.

The discussion indicated common misunderstandings about the meaning of terms such as the *return period* and the need for clear definitions[1]. It is hoped that continuing interaction between the participants of this workshop will ensure that research products provided for development, planning and policy purposes will be consistently defined and uniformly understood.

2.3 Some Specific Points That Were Raised

- Sea-level rise may impact coastal infrastructure through both damage (e.g. loss of a road structure) and disruption (e.g. loss of use of an undamaged road during periods of flooding). We believe that this was adequately acknowledged by the participants and addressed by the three Questions.

- Historic sites, buildings and artefacts have particular problems regarding sea-level rise in that they often cannot be moved to safer locations and that they are often particularly vulnerable to water damage (e.g. old buildings do not generally have damp courses). Exposure to multiple events in a short time may also increase the damage. A similar comment was made about natural values (e.g. coastal ecosystems) which cannot be moved and may not be able to adapt.

- The exact timing of extreme events may be important. For public services (e.g. sewerage, roads and camping grounds) there is a clear daily or seasonal cycle of use, which interacts with the timing of sea-level extremes. In the case of sewage systems, intrusion of seawater generally occurs during times of *low usage* and *high tides*. This is really an extension of the concept of *joint probability* of extreme events caused by different processes, with the inclusion of anthropogenic 'forcing'. Such problems, which involve specific techniques for combining probabilities, can really only be considered on an individual basis.

[1]The *Return Period* (otherwise known as the *Average Recurrence Interval* or *ARI*) is the *average value of the periods between exceedance events*. In other words, if there are N exceedance events in a period T, where N is large, then the Return Period is T/N. Another (and in some ways more useful) way of expressing the frequency of extreme events is by defining the probability that an event will occur during a specific time span. If this time span is one year, then this statistic is called the *Annual Exceedance Probability* or *AEP*. For Return Periods that are much longer than a year (say, greater than about 20 years), then the Return Period in years is closely approximated by the reciprocal of the Annual Exceedance Probability (i.e. $RP(\text{years}) \approx 1/AEP$). For this reason, the exceedance level for a Return Period of 100 years is often defined as the level which has a probability of 1% of being exceeded during one year. It must be remembered that this is only an *approximate* definition and one which does not hold for short Return Periods. For example, for a Return Period of one year, the Annual Exceedance Probability is 63% (not 100% as we might expect from the approximate definition). In summary, the frequency of extreme events may be expressed in two ways: either by the Return Period (or Average Recurrence Interval) or by the Annual Exceedance Probability; both are equally valid (they actually are related by $AEP = 1 - \exp(-1/RP(\text{years}))$, which is $\approx 1/RP(\text{years})$ for large $RP(\text{years})$).

The above illustrates nicely a common misunderstanding in the use of Return Periods. It is often believed, in planning a development for (say) 100 years, that designing for the exceedance level with a 100-year Return Period is sufficient – i.e. that the extreme will not occur until 100 years have passed. However, extreme events do not occur regularly with a period equal to the Return Period. Simple statistics show that the probability that an extreme with a 100-year return period will occur during the first 25 years is 22%, during the first 50 years it is 39% and during the first 100 years it is 63% – none of which gives much confidence that the level would not be exceeded during the life of the structure! In fact, if we require that there is only a probability of 1% that the level will be exceeded during 100 years, then we need to plan for exceedance levels with a Return Period of 9950 years.

- The adaptive response of port facilities to sea-level rise may be faster than that of other coastal infrastructure, because the time scale for port developments is only 10 to 20 years.
- There was general agreement that statistics on sea-level extremes should be provided at specific locations, rather than being all-embracing figures to cover the whole of Tasmania.
- One participant noted one of the few gains from sea-level rise: the ability of ships to handle more cargo due to larger bottom clearances in ports, a gain which may be reduced by constraints imposed by existing bridges.
- In order to improve planning in the future, we need to have in place adequate observing facilities. In the case of sea-level measurements, this may well require an expansion of the Tasmanian tide-gauge network. The only currently operating tide gauges in Tasmania are at Burnie, Devonport, Hobart and Spring Bay, there being no operating tide gauges on the northeast or west coasts. There is also no historical data of significant length on the northeast coast and the the longest existing record from the west coast (from Granville Harbour) is of only four years duration.
- There is a clear need for improved public awareness of the issues of both climate change and sea-level rise, and their consequent impacts.

3 The Future

We hope that information provided during the workshop will prove useful to the participants. For our own part, the workshop has enabled us to start a dialogue with a wide range of stakeholders within Tasmania and has given us an improved understanding of the way in which information on sea level extremes should be delivered.

As part of our ongoing research, we will shortly commence an investigation (supported by the Department of Tasmanian Primary Industries and Water) into extreme sea levels in southern Tasmania, and the way in which they will be affected by sea-level rise. This will be based primarily on historic tide-gauge observations from Hobart. This will be followed by a similar exercise in northern Tasmania. We will present the results of this work jointly with DPIW to interested people at a future workshop.

The Stakeholder Consultation Workshop had provided invaluable information guiding the way in which these results will be presented. We thank all those who participated.

4 Acknowledgements

The workshop was supported by the Tasmanian Department of Primary Industries and Water through their Climate Change Project.

Appendix A
Agenda of Workshop

Antarctic Climate & Ecosystems Cooperative Research Centre

Extreme Sea Levels: Stakeholder Consultation Workshop

Agenda

When and Where

Date: Wednesday 31 May
Time: From 10:45 am to 3:30 pm
Place: The Royal Yacht Club of Tasmania - Marieville Esplanade, Sandy Bay

Morning tea, a light lunch and afternoon tea will be provided.

Purpose

The workshop is aimed at presenting recent research into the changing frequencies of extreme events affecting our coasts, such as storm surge and inundation, and seeking your input on the information you need to manage the risks posed to your organisation by such events.

Timetable

10:45 - 11:00	Morning tea and registration	
11:00 - 11:10	Welcome	Prof Bruce Mapstone
11:10 - 11:45	Setting the scene – sea level rise and extreme events	Dr John Hunter
11:45 - 11:55	Questions	Dr John Hunter
11:55 - 12:10	Format for the day	Dr Rosemary Sandford
12:10 - 12:45	Lunch	
12:45 - 1:45	Breakouts	
1:45 - 2:45	Feedback and group discussion	Prof Bruce Mapstone
2:45 - 3:15	Afternoon tea	
3:15 - 3:30	Wrap up – and where to from here	Prof Bruce Mapstone

Acknowledgements

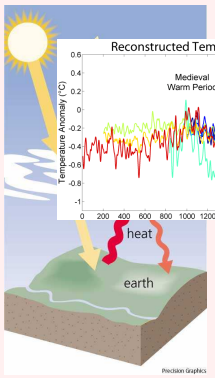
This ACE CRC workshop is supported by the Tasmanian Department of Primary Industries and Water through their Climate Change Project.

Post Workshop Feedback

Contact John Hunter: john.hunter@acecrc.org.au
03 6226 7849

Appendix B
Copies of Presentation
'Setting the Scene'

The "Greenhouse Effect"

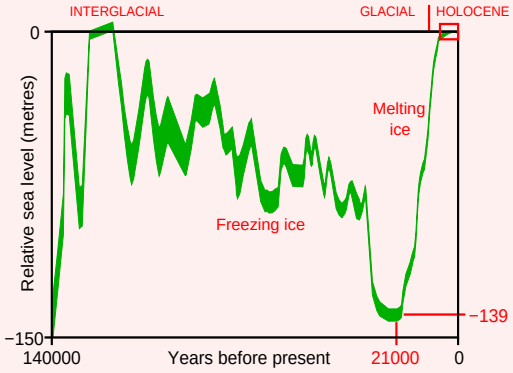


Warming → Expands oceans

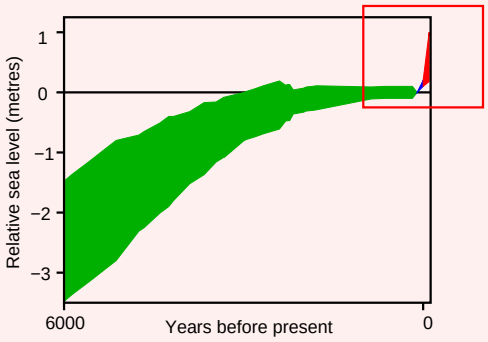
Melts glaciers

→ Sea−level rise

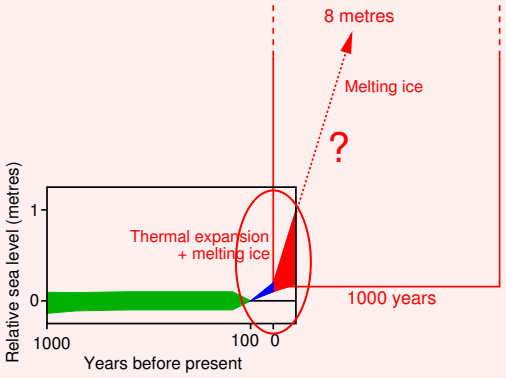
History of Global Sea Level Rise



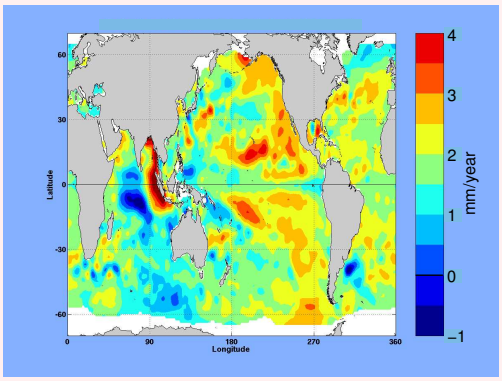
History of Global Sea Level Rise



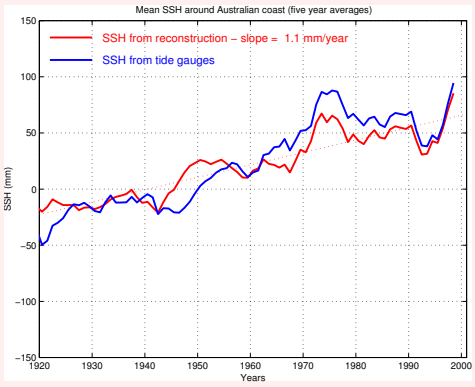
Where to Now?



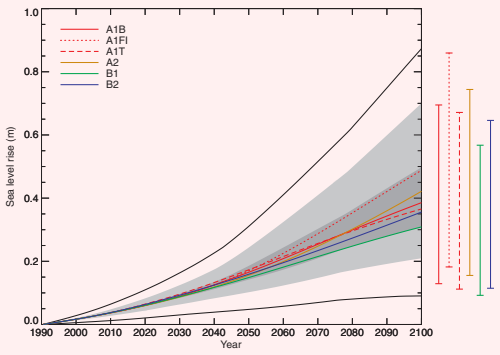
Global Variation in Sea Level, 1950–2000
(adjusted for land movement; Church et al.)



A Reconstruction of Australian Average Sea Level
(relative to the land; Church et al.)

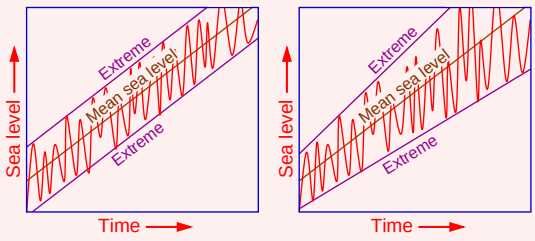


IPCC Global Average Sea Level Projections



(Projected rise 0.8 − 8 mm/year during 21st century)

Changes of Mean Sea Level and of Extremes

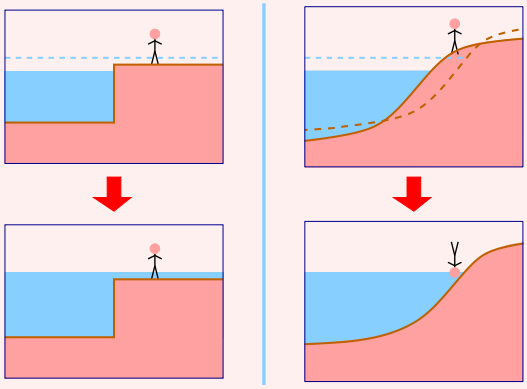


For Sydney and Fremantle:
annual to decadal events occurred
2−3 times more often after 1950
(mainly due to sea level rise)

Some Impacts of Sea Level Rise

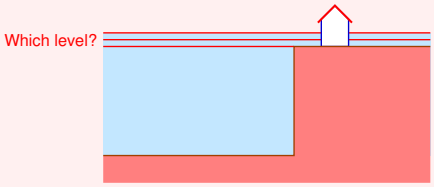
- Flooding of low–lying land
- Shoreline erosion:
  - 70% of world's sandy beaches receding, 10% prograding
  - Bruun rule for sandy beaches: 1 metre rise gives 100 metres recession (very roughly)
- Increased salinity due to rise of (saline) water table

Two Ways of Getting Your Feet Wet

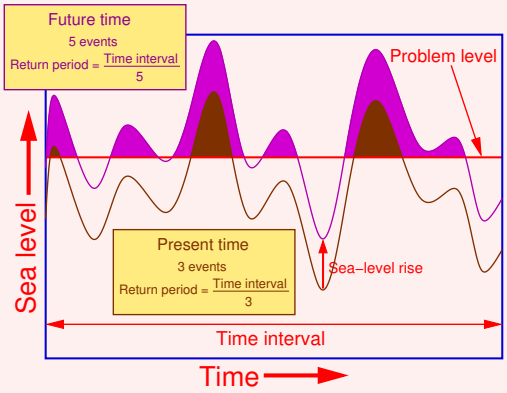


The "Problem Level"

- We will only consider flooding of fixed coastal infrastructure
- For your own particular problem, you will need to choose your problem level:



A Schematic Sea–Level Curve



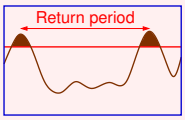
Why You Are Here

- We observe an increase in extreme high sea levels
- Most of this increase seems to be due to rise in mean sea level
- Therefore, from projections of rise in mean sea level, we can estimate the changes in extreme high sea levels
- We can provide advice to you concerning these changes
- However, we need your assistance in telling us how you would like these changes to be reported
- There is no single answer:

  We want to tailor our output to your requirements

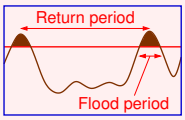
Three Important Questions

- Is the return period important?



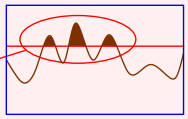
- Is the flood proportion important?

$$\text{Flood proportion} = \frac{\text{Flood period}}{\text{Return period}}$$

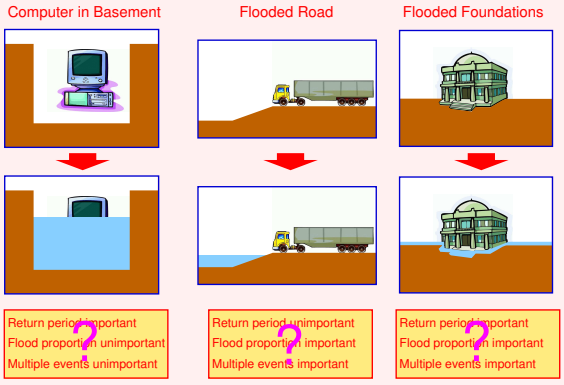


- Are multiple events important?

One event in a short period or three events?



Some Scenarios



So this is what we would like you to do:

1. Identify your primary interests (e.g. road transport)
2. Based on your interests, answer the three questions:
   - Is the return period important?
   - Is the flood proportion important?
   - Are multiple events important?

   with a "yes" or "no" and appropriate qualifications (e.g. "a multiple event occuring within a time span of two days can be considered a single event")
3. Suggest any other important questions

THANK YOU!

Appendix C
Attendees

Name	Organisation	Email	Phone
Christopher Beattie	State Emergency Service	christopher.beattie@ses.tas.gov.au	03 6230 2772
Kerry Boden	Resource Planning and Development Commission	Kerry.Boden@rpdc.tas.gov.au	03 6233 2841
Nick Bowden	Department of Primary Industries and Water	Nick.Bowden@dpiw.tas.gov.au	03 6233 2942
Richard Coleman	University of Tasmania	Richard.Coleman@utas.edu.au	03 6226 2108
Matt Davis	Department of Infrastructure, Energy and Resources	matt.davis@dier.tas.gov.au	03 6216 4348
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Gina Newton	Australian Greenhouse Office	gina.newton@deh.gov.au	02 6274 2453
Martin North	TasPorts	martin.north@tasports.com.au	03 6235 1014
Fleur O'Neill	Coastlink - Sustainable Living Tasmania	nrmsouth.marine@nrmsouth.org.au	03 6234 5566
Caleb Pedder	Aboriginal Heritage Office, Department of Tourism, Parks, Heritage and the Arts	Caleb.Pedder@heritage.tas.gov.au	03 6233 3927
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Rosemary Sandford	Antarctic Climate & Ecosystems Cooperative Research Centre	rosemary.sandford@acecrc.org.au	03 6226 2920
Ian Sansom	Department of Justice, Land Use Planning Branch	ian.sansom@justice.tas.gov.au	03 6233 6848
Alistair Scott	Department of Primary Industries and Water	Alistair.Scott@dpiw.tas.gov.au	03 6211 3986
Chris Sharples	Consultant Geoscientist	chris@sharples.com.au	03 6239 6307
John Stevens	Clarence City Council	jstevens@ccc.tas.gov.au	03 6245 8600
Alasdair Wells	Department of Primary Industries and Water	Alasdair.Wells@dpiw.tas.gov.au	03 6233 3230
Fiona Wells	Resource Planning and Development Commission	fiona.wells@rpdc.tas.gov.au	03 6233 2774
Neil White	CSIRO	Neil.White@csiro.au	03 6232 5222
Ruth Whiteley	Department of Infrastructure, Energy and Resources	Ruth.Whiteley@dier.tas.gov.au	03 6233 4463
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